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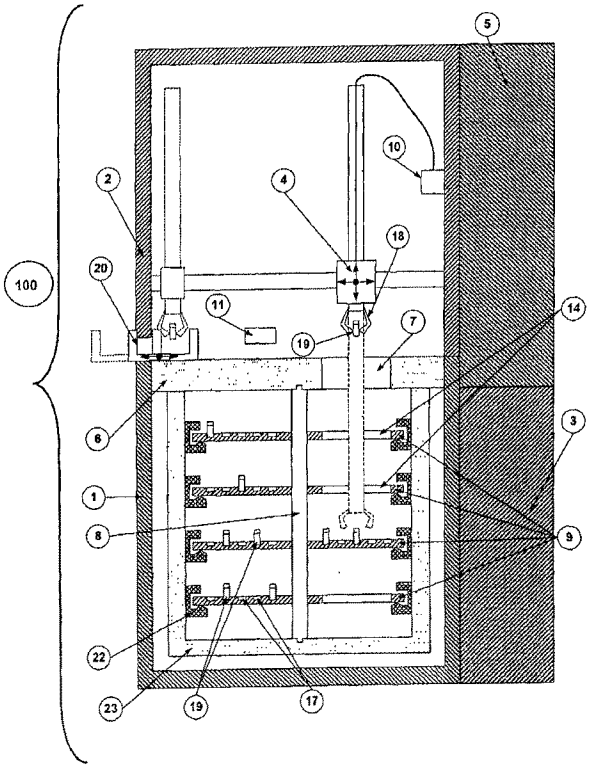
(54) Title: AUTOMATIC SYSTEM FOR CONSERVING SAMPLES AT A CONTROLLED TEMPERATURE



(57) Abstract: An automatic system (100) for conserving samples at a controlled temperature comprising at least one controlled-temperature thermo-insulated conservation chamber (1) with temperature control means (3) containing a set of disks (9) for storing samples (19) and a Cartesian robotic system (4) equipped with pick-up device (18), contained in an upper chamber (2) separated from the chamber (1) by means of an insulating shelf (6), where said Cartesian system (4) through the controlled-access opening (7) moves the samples (19) between the I/O drawer (20) and the above-mentioned set of disks (9). The combined and synchronized movement of the robotic device (4) and of every single disk of the set enables each storage location to be reached. The management of the devices of the automatic system (100) is controlled by an N/C system driven by dedicated management SW.

WO 2004/028572 A2

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"Automatic system for conserving samples at a controlled temperature".

* * * * *

The present invention comes within the sector of conservation devices and in particular refers to an automatic system for conserving samples in general and, in particular, biological samples at a controlled temperature.

Thermostatic devices are known for the conservation of samples of biological material at low temperature, which consist of freezers of the so-called horizontal type with opening from above and vertical type with front opening.

In said known devices the samples are conserved in containers, generally of small dimensions, positioned manually in baskets or supports moved manually.

The solutions that are available today are only controlled manually and have the following serious limitations:

- Human errors in manipulating,
- Human errors in identifying the samples,
- Exposure of the operators to the risks of biological contamination and burning in the event of accidental contact with low temperature parts.
- Intolerable slowness of the manual processes and consequent high managing costs.

The object of the present invention is to propose a system for the controlled-temperature conservation of samples, in particular of the biological type, which is capable of automatically moving said samples, in input and output, eliminating the above-mentioned limitations.

The object of the present invention is achieved in accordance with the contents of the claims.

The characteristics of the invention are highlighted with particular reference to the enclosed sheets of drawings, in which:

Figure 1 illustrates a side schematic view of the device of the present invention, in which several parts have been partially or totally removed to

highlight others better;

Figure 2 illustrates a section of the system illustrated in Figure 1 made with a horizontal plane;

Figure 3 illustrates the same section as Figure 2 with the disk rotated by a certain angle.

System 100 is mainly constituted by an assembly of two chambers 1 and 2 separated horizontally by a thermally insulated shelf 6 and functionally connected to each other, that have the aim, the first 1, positioned below, to contain the samples at controlled temperature and the second 2, positioned above the first, to contain, at ambient temperature, means for moving the samples between the two chambers and from the upper chamber towards the outside and vice versa.

The lower chamber is fitted with means 3 that control its temperature and which, as a non-limitative example, are positioned on a side of the same chamber.

In the same manner the upper chamber 2 is equipped with means 5 for controlling the robotized movement systems of the samples, which, as a non-limitative example, are positioned on a side of the same chamber.

Chamber 1 contains a stack of disks 9 totally centered on an axis 8 on which the locations 17 of the samples 19 are positioned.

The disks are supported individually by a group of three peripheral supports 22 positioned on three corresponding vertical uprights 23 connected to each other mechanically at 120°, so that the weight of each disk is born on its own supports 22 identically for all the disks.

Each disk is characterized in that it has a radial slot 14 associated to a zero notch such that the alignment on the notch itself ensures the consequent alignment of the slots of the disks on the same vertical. The disks 9 in position "0" have radial slots 14 on the same vertical as the controlled access opening 7 made on the shelf 6 of separation between chamber 1 and chamber 2. Said vertical alignment enables the Cartesian system 4 to

vertically penetrate the entire stack of disks with its pick-up device 18.

For the above the pick-up device 18 can reach any location laying on a previously rotated disk, passing through, sequentially, the opening 7 positioned on the insulating shelf 6 and all the radial slots 14 of the disks above the disk containing the location concerned. Therefore the sample 19 can be picked up or deposited in said location.

The "0" device 12 with which each single disk is provided immobilises in the position "0" all the disks except that containing the location concerned in the loading or unloading operation of sample 19; said disk rotates around axis 8 until it positions location 17 concerned on the vertical of the controlled access opening 7.

The position sensor 13, with which every single "0" 12 device is equipped, ensures that the position of the devices stopping the disks 9 is monitored, so that only the disk containing the location involved in loading or unloading is rotated starting from position "0".

At the same time a disk from the stack 9 containing the location to load or unload is released the corresponding device 21 is activated, starting the rotation of the disk until it presents the location involved on the vertical of the pick-up device 18 of the Cartesian robotic system 4.

As a non-limitative example the device 21 for the rotation of each disk can be made by a toothed wheel geared by command, by means of the device 24 on a motorized axis 25. The angular position of said motorized shaft 25 is monitored by an encoder of suitable resolution. Said toothed wheel 21 permanently engages a toothing position on the periphery of its corresponding disk of the stack 9.

The upper chamber 2 separated from the chamber 1 by the insulation shelf 6 also contains, in addition to the already mentioned robotic system 4, the system for identifying the sample 11, the optical sensor 10, the I/O drawer for the input/output of the samples 19.

The main aim of the separation produced by the insulation shelf 6 is to

maintain all the devices contained in the chamber 2 at ambient temperature so that they can be subjected to maintenance without interfering with the controlled-temperature chamber 1.

As non-limitative example, the robotic system 4 with at least two numerical control axes is composed of a skid for the horizontal movement which, in turn, conveys a vertical axis that is fitted with pick-up device 18 and the end part of an optical sensor 10 to obtain a return signal of the precision of the positioning of the gripper 18 in relation to the location 17.

As non-limitative example said optical sensor 10 can be made with an optical fiber device or with microcamera.

The combined electronic control of the movement of the disks and of the robotic system enables the locations of the samples to be managed automatically.

A fundamental feature of this automatic managing system 100 for the controlled-temperature conservation of samples is to establish an unequivocal connection between the storage location 17 and the sample 19 by using a procedure for identifying the sample with means 11 placed inside chamber 2 so that it is possible, in input or in output, to confirm the identity of the sample being moved.

As non-limitative example the identification system 11 can be a barcode reader, a tag reader, or preferably an identification device of a two-dimensional code marked directly on the surface of the sample.

The input and the output of the samples takes place using an I/O drawer 20 that places in communication, upon command, the external world with the upper chamber 2. The characteristic of the drawer 20 is that it forms a seal between the chamber 2 and the external world so that, both in the open position and in the closed position, the entrance of humid external air into chamber 2 is limited at a maximum extent.

The loading operation comes about by commanding the opening of the drawer that can be in this manner loaded with one or more samples. With the

closing of the drawer the samples are transferred inside chamber 2 where the robotized system 4 picks up each sample with the pick-up device 18 and, after the identification process carried out with device 11 deposits it in the required location.

The sample unloading operation comes about carrying out the operations described above in reverse order.

As non-limitative example the movement of the drawer 20 can be obtained by means of a pneumatic piston and the "open" and "closed" positions are monitored by special sensors.

The automatic management system 100 for the controlled-temperature conservation of samples makes use of a control system consisting of SW and HW modules whose main components are the following:

HW components:

- Electronic systems for piloting the axes, the sensors and the ID sensors,
- Electromechanical devices for the movement of the axes of the system,

SW components:

- Graphic interface with the operator,
- Management data base of the locations and the samples,
- Driver for the control of the axes,
- Robotic programs,
- Communication protocols between the internal devices, between each other and towards the external world,
- System diagnostics,
- Devices for remote control.

The invention described above is intended as being a non-limitative example, therefore any constructive variations come within the protective framework of the present technical solution, as described above and hereinafter claimed.

CLAIMS

1. An automatic system (100) for the conservation of samples (19) comprising at least a controlled-temperature thermo-insulated storage chamber (1) containing a set of disks (9) fitted with a radial slot (14), locations (17) for storing said samples (19) and a Cartesian robotic system (4), contained in a chamber (2) above and separated from the chamber (1) by means of an insulating shelf (6) fitted with a controlled access opening (7), the Cartesian robotic system (4) being fitted with a pick-up device (18) that moves the samples (19), characterized in that said pick-up device (18) moved by the Cartesian system (4) can reach any location (17) of one of the disks of the stack (9) passing through, sequentially, the controlled-access opening (7) of the insulating shelf (6), the radial slots (14) of the set of disks (9) lying above the location (17) involved.

2. System as per claim 1 in which every disk of the stack (9) is held by a group of three supports (23) positioned at 120° at the periphery of each single disk.

3. System as per claims 1 and 2 in which each single disk (9), and only one disk at a time, can be rotated by means of a device (21), which couples on the corresponding periphery of each disk (9).

4. System as per claim 3 in which a complex of toothed wheels (21) always in contact on the peripheral toothing of the corresponding disks (9) and of a engaging device (24) integral with a motorized shaft (25) which is suitably commanded places in rotation only one toothed wheel (21) and thus the corresponding disk of the stack (9).

5. System as per claims 1 and 4 in which all the disks (9) are held blocked by the "0" device (12) with the slots (14) aligned vertically, except for the disk whose rotation brings the location (17) under said slots.

6. System as per claims 1, 4 and 5 in which the disks blocking device (12) is fitted with a sensor (13) capable of monitoring the position of said

blocking device and, at the same time, the position of "0" of each disk held blocked.

7. System as per previous claims in which the disk of the stack (9) that is placed in rotation by the device (21) is monitored in its angular position by means of an encoder mounted on the motorized pulling shaft (25).

8. System as per claim 1 in which the chamber (2) contains a device for identifying the samples (11) in input to and output from the system (100).

9. System (100) as per claim 1 in which the operations of inserting and extracting the samples from the system comes about by means of an I/O drawer (20) that connects the external world with the chamber (2) containing, amongst other things, the robotic device (4).

10. System (100) as per claim 1, in which the access to the samples can come about only by means of the robotized system (4) and that is, it cannot come about with manual type intervention.

11. System (100) as per claim 1, in which the controlled-access opening (7) on the thermally insulated panel (6) is fitted with bodies that keep said opening closed so that the specific bodies open said opening only when the sample pick-up device passes.

12. System (100) as per claim 1, in which the pick-up device (18) of the sample (19) is equipped with an optical sensor (10) for monitoring the correct positioning of said pick-up device in relation to the location of the sample.

13. System (100) as per previous claims in which each mechanism for driving and access to the storage chamber (1) is contained in the chamber (2) permitting maintenance activity to be carried out on said devices without interfering with the controlled-temperature chamber (1).

14. System (100) as per previous claims, in which the entire management of the devices of the system is controlled by an N/C system driven by a dedicated management SW.

15. System (100) as per previous claims, in which the robotized system is controlled by an SW that records every operation set up by an operator and carried out by the system (100).

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Fig.1

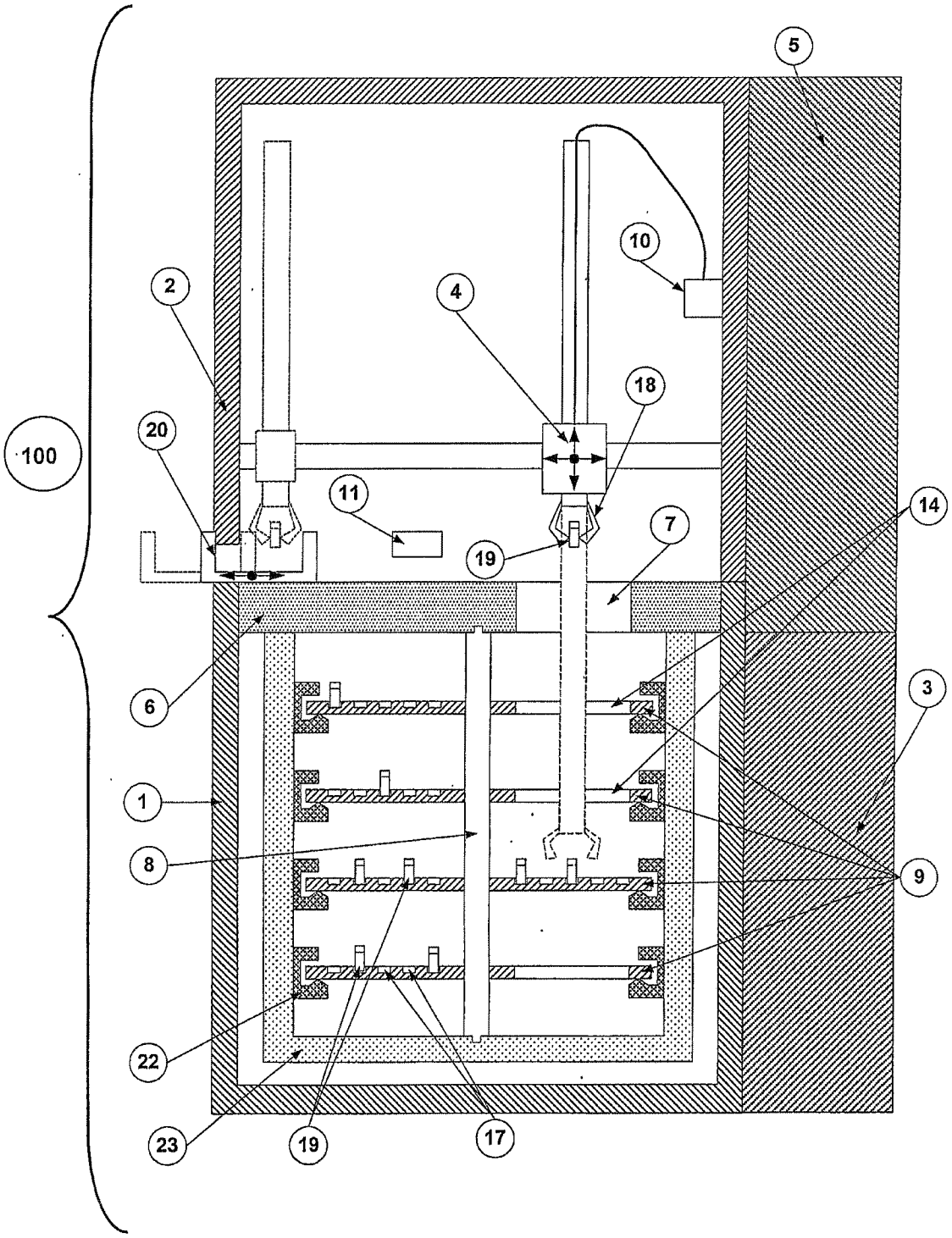

Fig.2

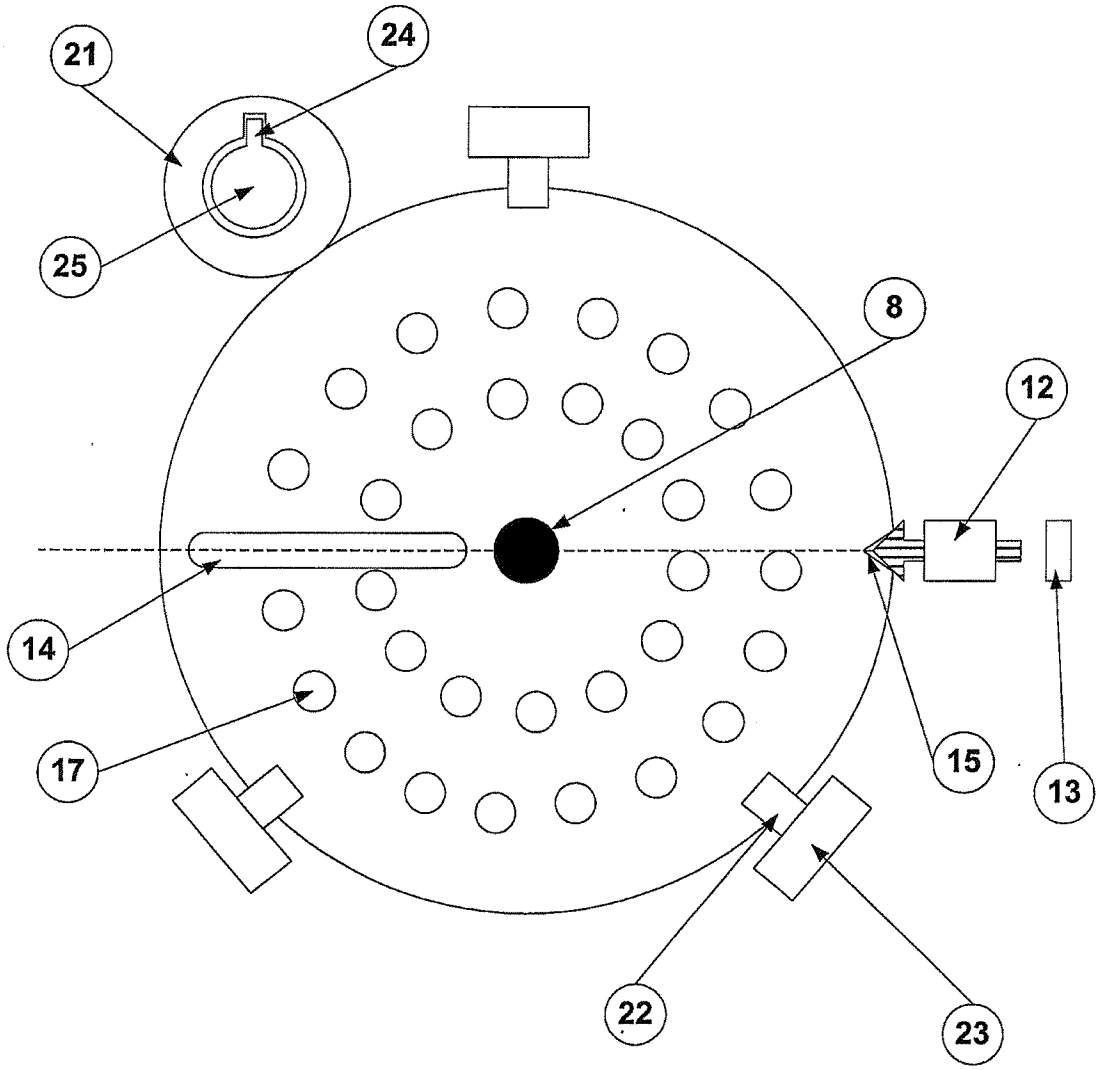

Fig.3